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Valuation of human health: An integrated model of willingness to pay for mortality and morbidity risk reductions ☆

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ABSTRACT

This paper develops and applies an integrated model of mortality and morbidity valuation that is consistent with the principles of welfare economics. To obtain the integrated model, the standard one-period expected utility model of one person facing the prospect of either being alive or dead is extended to incorporate (1) a third health state (sick) with a utility level that is intermediate to utility if healthy and utility if dead, (2) a family perspective in which a parent makes choices about risk exposure both for herself and for a child, and (3) a multi-period framework that allows for possible parent/child differences in illness latency. Monetary benefits of health risk reduction obtained from the integrated model are compared with those that would be computed using the standard model. The integrated model then is applied using data obtained from two field studies of skin cancer and leukemia to demonstrate how it can be used to estimate health benefits of reduced illness and death risks.

Introduction

Valuation of improvements in human health is a central feature in benefit–cost analyses of public programs to reduce environmental hazards such as air pollution (e.g., U.S. Environmental Protection Agency, 2011). Benefit–cost studies generally divide human health improvements into two categories, reduced mortality and reduced morbidity. Valuation of

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reduced mortality is achieved using an estimate of the value of a statistical life (VSL) that is assumed to be applicable across many types of mortality risk.[1] Total health benefits then are obtained by adding the value of reduced mortality to independently estimated, disease-specific values of reduced morbidity. A recent white paper released by the U.S. Environmental Protection Agency's National Center for Environmental Economics (2010, p. 8) concludes that this procedure is deficient because mortality risks and morbidity risks are intertwined; thus benefits of reduction in each would ideally be based on an integrated model. Developing such a model, however, was considered to be beyond the scope of the white paper and near the frontier of the empirical valuation literature.

This paper (1) develops an integrated model of human mortality and morbidity valuation that is consistent with the principles of welfare economics and (2) demonstrates how this model can be empirically implemented. In particular, the standard one-period expected utility model of one person facing the prospect of being either alive or dead is extended in three directions. First, to develop a theoretical link between mortality and morbidity valuation, the proposed model envisions that a person faces the prospect of being healthy, sick or dead.[2] Inclusion of the "sick" health state allows an illness to leave a person alive, but with a lower level of utility than would be enjoyed in the healthy state. Second, to allow for the possibility that parents value risks to their children's health differently than they value risks to their own health, the model is developed in a setting with two family members, a decision-making parent and a child.[3] Third, the role of possible parent/child differences in illness latency is highlighted by extending the one-period model to a simplified multi-period framework. The model then is applied to obtain morbidity and mortality values for both parents and their children using two data sets on cancer risk reduction in the U.S.[4]

The conceptual analysis presented yields two main insights. The first turns on the possibility that the marginal probability of getting sick (S), referred to as (marginal or unconditional) morbidity risk, and the conditional probability of death given that sickness occurs (D), referred to as conditional mortality risk, are perfect substitutes.[5] As the term is used in this paper, perfect substitution means indifference between alternative combinations of S and D that leave $r = SD$ unchanged, where r is referred to as (unconditional) mortality risk. The model demonstrates that in the special case in which S and D are perfect substitutes, total health benefits of a small reduction in an environmental hazard are entirely captured by the marginal willingness to pay to reduce mortality risk. Increasing the total health benefit estimate by adding in a separate value to reflect reduced morbidity risk would result in double-counting. On the other hand, if S and D are not perfect substitutes, total health benefit estimation requires a more nuanced calculation involving a weighted sum of mortality and morbidity benefits.

A second conceptual result is that a parent's marginal willingness to pay to reduce a given health risk to herself will not generally equal her marginal willingness to pay to reduce this same risk to her child. At the margin, she may be willing to pay a higher or lower amount to protect herself in comparison to the amount that she would pay to protect her child depending on the utility levels that she would experience in various health states, the relative probabilities of these possible occurrences, and the differing lengths of time that she thinks it might take for her and for her child to become ill. This result highlights the difficulties inherent in the practice sometimes followed in policy analysis in either implicitly or explicitly transferring to children estimates of the VSL obtained for adults.

The conceptual analysis is used to motivate three aspects of the empirical work. First, the model is used to support estimation of parents' marginal willingness to pay to reduce both morbidity risk and conditional mortality risk to themselves and to their children. Second, the multi-period analysis suggests a method for estimating the discount rate that parents apply to latent risks. Third, the model provides the basis for testing whether morbidity risk and conditional mortality risk are perfect substitutes. Most labor market studies that estimate the VSL using wage-risk data do not consider on-the-job injuries together with the conditional probability that an injury will lead to death and instead focus on unconditional risk of immediate death from an industrial accident. Thus, it is not surprising that the issue of perfect substitution between S and D has not come up. In contrast, the possibility of perfect substitution may be more important to consider in studies of environmental exposures that can eventually lead to a prolonged period of illness, followed by death.

Empirical estimates are based on stated preference data obtained in two field studies of skin cancer and leukemia risks to parents and their children. Use of stated preference data is controversial partly because respondents are often thought to overstate their purchase intentions when they do not actually have to pay (Hausman, 2012). In both field studies, however, hypothetical bias is controlled by focusing on marginal willingness to pay (Vossler et al., 2012), through aspects of the

[1] Cameron (2010) discusses alternative ways to scale reductions in mortality risk to avoid misconceptions associated with the term "value of a statistical life". The units in which mortality risk is measured, however, do not materially affect the results presented here. In any case, this paper retains the more traditional terminology used in benefit–cost studies of environmental hazards that affect human health.

[2] In policy oriented studies, the value of reduced morbidity is often established from an *ex post* perspective using medical costs and lost work time incurred by those suffering from particular diseases. Alberini and Krupnick (2002, p. 234) point out that this approach is not consistent with the principles of welfare economics. This paper, in contrast, takes an *ex ante* view in which the value of reduced morbidity rests on the monetized difference between utility if healthy and utility if sick.

[3] Recent empirical studies (e.g., Dickie and Messman, 2004; Hammitt and Haininger, 2010) have estimated that parents are willing to pay more to reduce hazards to their children than they are to reduce the same hazards to themselves.

[4] Cameron and DeShazo (2013) also seek to overcome limitations in valuing reductions in risk to human health, but do not consider issues that are central to the present paper including parents' valuation of their children's health.

[5] To avoid later confusion, the terms "risk" and "probability" are used interchangeably. Risks that are conditioned on a particular event are referred to as conditional risks.